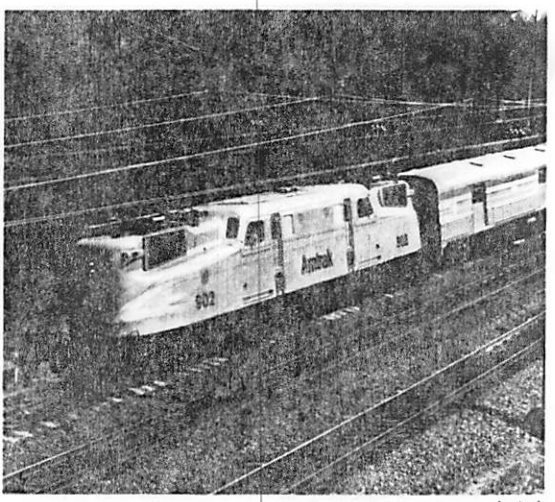
Santa Fe Railway

Diesel Locomotives pull most freight and passenger trains and handle most yard-switching work. The diesel-electric, above, is the most widely used kind of diesel in the world.



Amtrak

Electric Locomotives run on power supplied by an electric power plant. These locomotives are especially useful for hauling high-speed passenger trains or fast, heavy freight trains.

LOCOMOTIVE is a machine that moves trains on railroad tracks. Early locomotives weighed from 3 to 6 short tons (2.7 to 5.4 metric tons) and could pull or push only a few light cars. A modern locomotive may weigh over 700 short tons (640 metric tons) and move more than 200 loaded freight cars at a time.

Locomotives designed to haul freight or passenger trains are called *road locomotives*. A *yard switcher locomotive* moves cars from track to track in railroad yards. A *general purpose locomotive* can be used to haul trains or for yard switching.

There are three main kinds of locomotives, depending on their source of power: (1) diesel, (2) electric, and (3) steam. A fourth kind, powered by machines called *gas turbines*, once hauled some freight in the United States. Railroads no longer use such locomotives, but gas turbines do power certain high-speed, lightweight passenger trains called *turbotrains*. Such turbines resemble those used in aircraft. Turbotrains do not have locomotives. Instead, their power units are built into one or more of the cars.

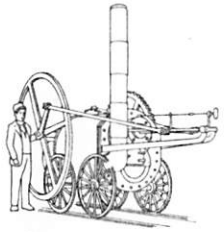
Steam locomotives once pulled most railroad trains, and they are still used in some countries. But in the United States, diesel locomotives have replaced other kinds almost entirely. In the mid-1970's, U.S. railroads operated about 27,000 diesels and about 200 electric locomotives. About 100 steam locomotives remained in operation. They were used chiefly to pull tourist trains.

Kinds of Locomotives

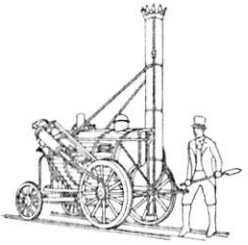
Diesel Locomotives are actually traveling power plants. They have a diesel engine that works by compressing air in chambers called *cylinders*. When air is compressed, its temperature rises. The resulting heat ignites fuel that has been injected into the cylinder. The power produced during this process is then transmitted to the locomotive's driving wheels. For more detailed information on how a diesel engine works, see the WORLD BOOK article on DIESEL ENGINE.

Diesel locomotives have a number of advantages. They generate their own power and therefore can operate anywhere that there are rails. Diesel locomotives can also make long runs without refueling or servicing. They can be quickly stopped or started, and they speed

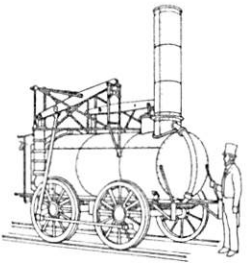
HISTORIC LOCOMOTIVES Many early locomotives contributed to the development of today's streamlined models.



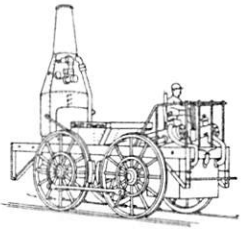
The First Locomotive was a simple steam engine built by Richard Trevithick of England. It made its first run in 1804.



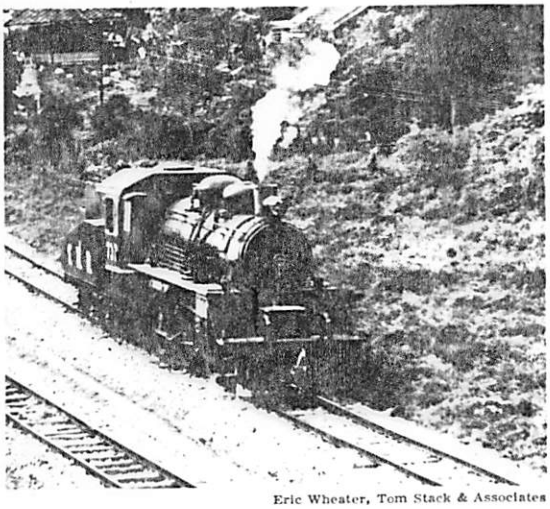
The *Rocket,* the first truly successful steam locomotive, was built by George Stephenson of England in 1829.



The *Stourbridge Lion,* a steam engine, in 1829 became the first full-sized locomotive to run on rails in North America.



The *Best Friend of Charleston,* the first U.S. steam locomotive put in regular service, began operating in 1830.



Eric Wheater, Tom Stack & Associates

Steam Locomotives hauled nearly all trains before the invention of the diesel. Today, such steam engines as the one above still provide train service in some parts of the world.

up faster than steam engines. They also have a higher fuel efficiency than steam locomotives, require less servicing, and cost less to maintain.

A diesel locomotive may be a combination of one to four or more connecting units. These units are of two general types, called A and B. An *A unit* is designed and equipped for use by itself or as a lead unit when a number of units are combined. A *B unit* does not have the engineer's cab and controls needed to serve as a lead unit, and it is capable of only limited independent movement. A diesel locomotive may consist of a single A unit or of two, three, four, or more A and B units coupled together.

In the United States, railroads often use locomotives with six or even more units to pull heavy trains at high speeds or on mountain grades. Sometimes one or more *radio remote control units* are also used on extremely long trains. These units are placed near the middle of the train. The engineer controls them by radio signals from his cab, which is located in the lead unit at the front of the train.

Diesel locomotive units range from 400 to 6,600 horsepower (300 to 4,920 kilowatts) each. Most of those in freight and passenger train service run from 1,500 to 3,000 horsepower (1,120 to 2,200 kilowatts). Two 3,000-horsepower units coupled together make a 6,000-horsepower locomotive.

There are three types of diesel locomotives: (1) diesel-electric, (2) diesel-hydraulic, and (3) diesel-mechanical. Each transmits power from the engine to the driving wheels in a different way.

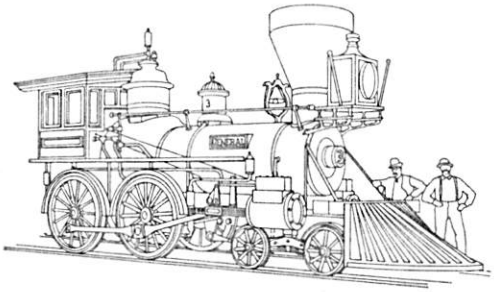
Diesel-Electric Locomotives are by far the most common type. Almost all locomotives in the United States are diesel-electrics. In these locomotives, the engine drives a machine called a *generator*, which produces an electric current. The current is then fed to *traction motors*, which drive gears that turn the locomotive's driving wheels.

Most diesel-electrics have generators that produce *direct current* (DC), a kind of current that flows in only one direction. Generators on some newer, large diesels produce *alternating current* (AC), which reverses direction many times every second. Most diesels have traction motors that operate on direct current. Therefore, locomotives with an AC generator must *rectify* (convert) the alternating current into direct current before it goes to the motors. Devices called *silicon rectifiers* perform this conversion.

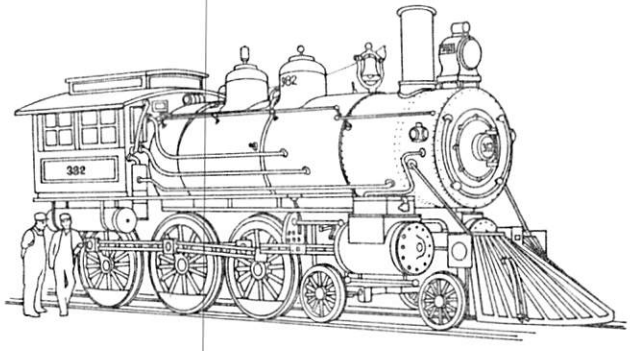
Diesel-Hydraulic Locomotives. In this type of locomotive, the engine drives a *torque converter* instead of a generator. A torque converter is a device that uses fluids under hydraulic pressure to transmit and regulate power received from the engine. The converter includes a pump and a turbine. The turbine changes energy from the fluids into a force that can be used to perform work. The engine delivers oil to the converter and drives the pump. The pump forces the oil against the blades of the turbine. This action causes the turbine to rotate and to drive a system of gears and shafts that move the wheels.

Diesel-hydraulic locomotives are not used in the United States. However, they are widely used in some other countries, especially in Germany, where they first appeared.

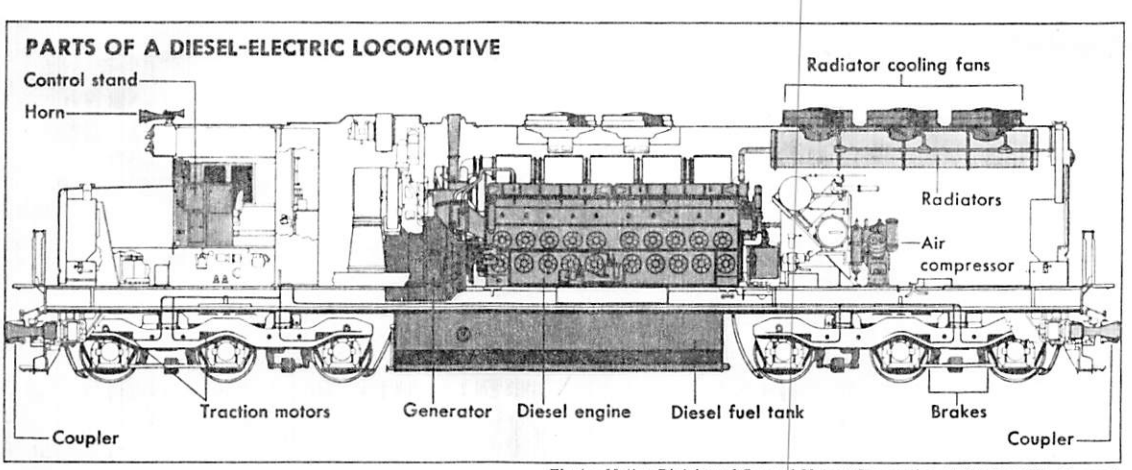
Diesel-Mechanical Locomotives transmit power from the engine in much the same way that automobiles do—through a clutch and a system of gears and shafts. The clutch connects the engine to the transmission. The



The *General,* a Confederate steam locomotive, became famous after Union troops captured it in 1862, during the Civil War.



***Engine* 382** was the locomotive driven by the famous Casey Jones, who in 1900 gave his life to save his passengers.



Electro-Motive Division of General Motors Corporation (WORLD BOOK diagram)

Inside a Diesel-Electric Locomotive, a diesel engine turns a generator. Electricity produced by the generator runs traction motors that drive the wheels. An engineer regulates power and speed at the control stand, and the air compressor powers the brakes. The radiator equipment keeps the engine from overheating. *Couplers* connect the locomotive with other units.

gears and shafts fit together to transmit the power and drive the wheels. This mechanical drive delivers less power than do other systems, and so it works well only on small locomotives.

Electric Locomotives, unlike diesels, do not produce their own power. They use electric power supplied by a central power plant that may be miles away. Therefore, an electric locomotive needs special wires or rails from which it can get power.

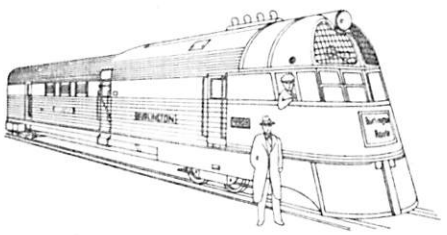
Most electric locomotives in the United States use alternating current. They obtain the power from an overhead wire called a *catenary*. A hinged steel framework called a *pantograph*, which conducts electricity, connects this wire with the locomotive. Locomotives that operate on alternating current receive power at extremely high voltages. They have a device called a *transformer* that reduces the voltage to a level at which it can be used. The power is then fed into AC traction motors, or it is rectified and fed into DC traction motors.

Some locomotives that operate on direct current also obtain power by way of a catenary and pantograph. Other DC locomotives use an *electrical third rail*, which runs parallel to the regular rails. A metal device called a *contact shoe* is attached to these locomotives. The shoe slides along the rail and picks up electricity from it.

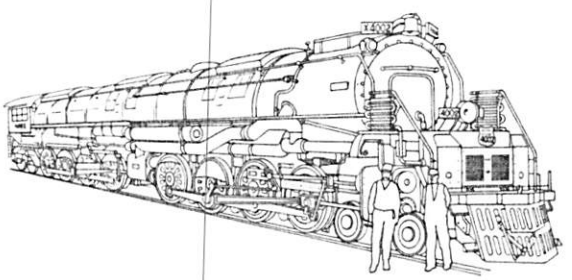
An electrified rail network costs a tremendous sum to build because of the wires and other special equipment involved. However, electric locomotives can draw vast amounts of power from their central power plant. Diesels, on the other hand, are limited to the power they can produce themselves. Electric locomotives can be started instantly. They also are quiet and produce no smoke or exhaust gases. Therefore, they are sometimes used in heavily populated areas and on railroads that run underground or through long tunnels.

Like diesels, most electric locomotives can operate either singly or combined in groups of two or more units. However, electric locomotives can produce more power per unit than diesels can. Therefore, electric locomotives are especially useful for fast, heavy freight trains or high-speed passenger trains.

Many kinds of fuel can be used by a power plant to produce the electricity that runs an electric locomotive. For example, a power plant may use coal, gas, oil, water power, or atomic power. Diesel locomotives can run only on diesel oil, which someday may become scarce and costly. For this reason, some U.S. trans-



The Burlington *Zephyr* was the first streamlined passenger diesel in the United States. It went into operation in 1934.



The *Big Boy,* a Union Pacific Railroad engine, was the largest steam locomotive in history. It was built in the early 1940's.

portation experts believe that electrification of the nation's railroads may in time become widespread.

Steam Locomotives produce heat by burning coal or fuel oil in a *firebox*. The heat turns the water in the locomotive's *boiler* into steam, which is fed into cylinders. There, the pressure produced by the steam drives steel rods called *pistons*. The pistons are connected to *piston rods*, *main rods*, and *side rods*, which move the driving wheels. A steam locomotive has an attached car called a *tender* that carries the fuel and water.

Steam locomotives have several disadvantages and have been largely replaced by other kinds. For example, a steam locomotive needs frequent care, especially to keep the fire burning in the boiler. A long time is required to light the fire and to heat the boiler so that steam can be produced. In addition, steam locomotives cannot maintain the high average speeds of diesel or electric locomotives. They also have low fuel efficiency. A steam locomotive must burn large amounts of fuel to produce power, but little of the heat produced is used to run the locomotive. The rest is wasted.

History

Richard Trevithick of England invented the steam locomotive in 1804. In 1825, Colonel John Stevens built the first steam locomotive in the United States. This locomotive, an experimental model, ran on a circular track at Hoboken, N.J. These first locomotives had many failings. In 1829, George Stephenson, another Englishman, developed the first really successful locomotive. It ran on smooth rails and had direct drive between the cylinder pistons and the driving wheels. Also in 1829, a Pennsylvania canal company tested the first full-sized locomotive to be operated on a commercial railroad in the United States. The locomotive, the *Stourbridge Lion*, was built in England.

In 1830, a famous race was held between a horse and a steam locomotive, the *Tom Thumb*. Peter Cooper, a New York manufacturer and builder of the locomotive, wanted to convince officials of the Baltimore and Ohio Railroad to use locomotives rather than horses to pull their trains. The horse won the race after an engine belt slipped on the *Tom Thumb*.

The first steam locomotive to be placed in regular passenger and freight service in the United States made its first run on Christmas Day in 1830. This locomotive, called the *Best Friend of Charleston*, was built by the West Point Foundry of New York for the South Carolina Canal and Rail Road Company. Steam railway transportation then developed rapidly.

The *General* was another famous steam locomotive of the 1800's. The *General* became legendary during the Civil War (1861-1865) after Union soldiers captured it from the Confederacy. The soldiers drove the locomotive northward from Georgia to Tennessee, destroying telegraph communications along the way. After a long chase, Confederate troops in another engine caught up with the *General*.

The electric locomotive was introduced in the late 1800's. Many men contributed to the development of the electric locomotive. Thomas Edison tested his first model in 1880, and the first electric street railway began operating in Germany in 1881. In 1895, the first electric locomotives were placed in regular railroad service by the Baltimore and Ohio Railroad in Baltimore.

Most American railroads continued to use steam locomotives until they began switching to diesels in the 1930's and 1940's. Huge, powerful steam locomotives called *Big Boys* were built from 1941 to 1944 to handle the freight traffic of World War II.

Diesel locomotives were introduced experimentally in 1923, when a switching unit was tested by several American railroads. In 1925, the first diesel placed in regular service by an American railroad began switching operations in a New York City freight yard. The first passenger diesel, the Burlington's *Zephyr*, went into operation in 1934. The first freight diesels went into service in 1940.

Within a few years, diesel locomotives were hauling passenger trains in various parts of North America and taking over much of the freight and yard work. By 1960, diesels had replaced all the steam locomotives in regular service in the United States.

Today, research engineers are working to develop locomotives of higher horsepower and greater pulling power. They also are seeking ways to make locomotives easier to maintain and more reliable. THOMAS C. SHEDD

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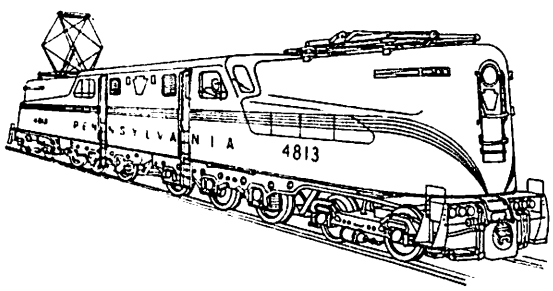
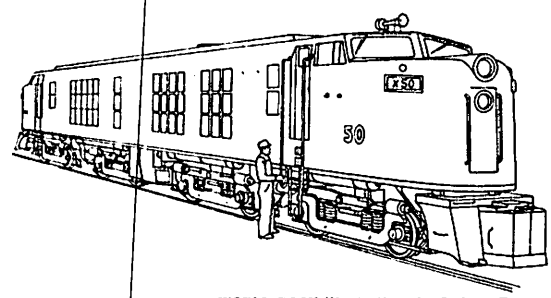
Electric Railroad
Free-Piston Engine
Jones, Casey
Railroad
Rocket, The
Steam Engine
Stephenson
Tom Thumb



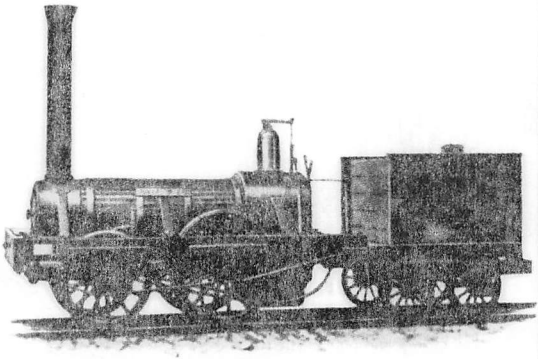
An Early Electric Locomotive, built in 1935, hauled passenger trains for the Pennsylvania Railroad for 32 years.



WORLD BOOK illustrations by Jackson-Zender

The First Gas-Turbine Electric Locomotive built and operated in the United States went into service in 1949.

BALDWIN, ROBERT



Franklin Institute

Old Ironsides, a locomotive designed and built by Matthias Baldwin, was made of iron and wood. It could travel up to 28 miles (45 kilometers) per hour. *Old Ironsides* remained in active service for more than 20 years in Pennsylvania.

process for plating gold. He entered a manufacturing business in 1825. Later, he designed a process for printing designs on cloth and built a noiseless engine.

After 1832, Baldwin devoted his time to improving and building locomotives and stationary engines. In 1842, he patented a locomotive design that solved the problem of moving around curves. The Baldwin Locomotive Works, established in 1854, manufactured more than 1,500 locomotives before Baldwin's death.

Baldwin was born in Elizabethtown, N.J. He became interested in tools and mechanical devices when he was apprenticed to a jeweler during his youth. Baldwin helped found the Franklin Institute and a school for Negro children.

ALFRED D. CHANDLER, JR.